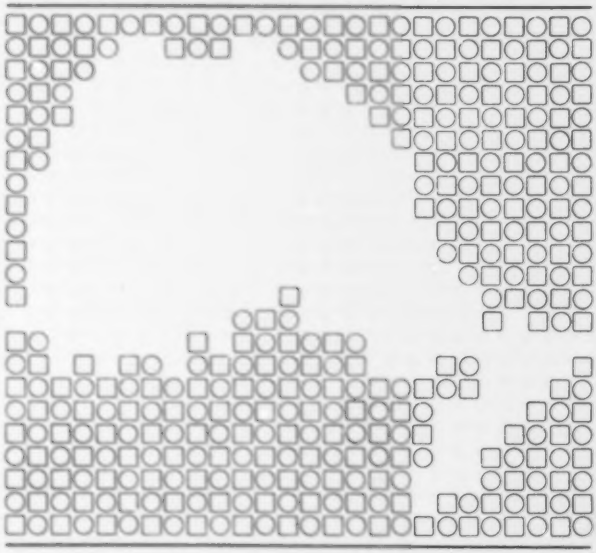
Ontario
Ministry of
Labour

Occupational
Health and Safety
Division

Designated Substances in the Workplace: A General Guide to the Regulations



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Designated Substances in the Workplace: A General Guide to the Regulations

February 1985

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Table of Contents

		Page
Introduction		1
1.	**An Overview of the Regulations**	5
	Are You Covered by the Regulation?	5
	Who Is Responsible for Implementing the Regulation?	5
	What Is the Responsibility of the Joint Health and Safety Committee?	6
	What Is the Exposure Limit for the Substance?	7
	How Is the Lowest Practical Level Determined?	8
	How Is Exposure Kept Below the Exposure Limits?	8
	When Can Respiratory Equipment Be Used?	9
	What Is An Assessment and Why Is It Performed?	9
	When Is An Assessment Necessary?	10
	Who Conducts the Assessment?	10
	What Must be Considered When Conducting An Assessment?	11
	What Is the Control Program and Why Is It Necessary?	11
	When Is a Control Program Required?	11
	Who Is Responsible for the Control Program?	11
	What Form Must a Control Program Take and Who Receives a Copy?	12
	What Must the Control Program Include?	13
	What Happens if There Is a Dispute Between the Joint Committee and the Employer Over the Assessment or Control Program?	

2.	**The Assessment**	14
	Identify Materials	15
	Draw a Map	15
	The Process Flow	15
	Gather Information on Processes and Controls	16
	Inspection of the Workplace	19
	Air Sampling and Medical Examinations	25
	Organize Your Information	25
	Review and Analysis	25
	Writing the Assessment	26
	Conclusion of the Assessment	27
3.	**Developing the Control Program**	28
4.	**Controlling Exposures**	30
	Engineering Controls Are the Best Defence	30
	Work Practices Can Ensure Safe Working Conditions	35
	Hygiene Practices and Facilities	37
	Administrative Controls Reduce Individual Exposures	38
5.	**Personal Protective Equipment**	41
	Protective Clothing	41
	Respiratory Protection	42
	A Detailed Program for Respirator Use Is Essential	44
6.	**Air Monitoring and Exposure Records**	48
	Personal or Area Sampling	49
	Duration of Sampling	50
	When to Conduct Sampling	51
	How to Calculate the Time-Weighted Average Exposure	52
	Determining the Personal Exposure of Workers	56
	Posting and Record Keeping	59
	Frequency of Air Monitoring	60

Air Sampling Personnel 60
Analysis of Air Samples 61

7. **The Medical Surveillance Program** 62
Who Is Responsible for the Medical Surveillance Program? 63
What Provisions Are Required for Medical Examinations? 63
Who Should the Examining Physician Be? 64
What Is the Purpose of the Clinical Tests? 64
What Must the Physician Tell the Employer? 65
What Else Must the Physician Report? 65
How Should the Employer and the Committee Act on Medical Information? 66
What Records Does the Physician Keep? 67
Who Can Get a Copy of the Records? 67
Can the Records Be Computerized? 68

8. **The Control Program - Putting It in Place** 69

9. **Other Information:**
Selected References 71
Ministry of Labour District Offices 73
Safety Associations 76
Occupational Health and Safety Resource Centres 77
Other Sources of Information 78

Introduction

The guide has been prepared to help employers, workers, members of joint health and safety committees, supervisors and occupational health personnel meet the requirements of the designated substance regulations that apply to biological, chemical or physical agents in the workplace, and to understand the responsibilities these regulations place on all participants in the workplace health and safetv system.

The advice in this guide is the interpretation by officials of the Occupational Health and Safety Division of the Occupational Health and Safetv Act (the Act) and regulations.

The advice does not have binding effect, but is intended to provide general answers to possible questions asked in the context of a specific fact situation. It is being used by staff of the ministry to assist in the administration of the regulations.

Questions of construction and application will find their ultimate answer given by the courts where a contest ensues as to construction or application of a legislative provision.

The Occupational Health and Safety Division of the Ministry of Labour is responsible for administering the Act.

One of the major issues facing employers, workers, the division and others is the control of worker exposure to toxic substances in the workplace. The Act places duties on employers to take all precautions reasonable in the circumstances to protect the health of workers. Employers are also required to comply with regulations and to provide information, instruction and supervision to workers.

The Regulations for Industrial Establishments, Construction Projects, and Mines and Mining Plants contain more specific requirements to control toxic substances in each sector. In other sectors such as hospitals and educational establishments, the ministry relies upon the general provisions of the Act. In many cases the control of toxic substances is supplemented by guidelines for worker exposure such as are contained in the booklet of threshold limit values published and updated annually by the American Conference of Governmental Industrial Hygienists.

Another approach used by the ministry has been the development of regulations to control worker exposure to particular toxic substances. These are known as designated substance regulations. A designated substance is defined by the Act as a biological, chemical or physical agent or combination of agents for which a regulation has been made to prohibit, regulate, restrict, limit or control worker exposure. At present, each designated substance regulation applies to a single agent or class of agents and sets out requirements governing exposure limits, use of respirators, air monitoring, medical surveillance and record keeping. In the future, as control strategies are reviewed, regulations may apply to broad groups of substances and may not contain all the features of existing designated substance regulations.

At the time of publication there were regulations in place for lead, mercury, asbestos, vinyl chloride, coke oven emissions, isocyanates, silica, benzene and acrylonitrile. The ministry has published Notices of Possible Designation to regulate noise, arsenic, formaldehyde, cadmium, chromium, ethylene oxide, styrene, nickel and coal tar products.

These regulations incorporate a number of approaches to occupational health that are new to Ontario. Among the most important of these are provisions for an assessment of the likelihood of worker exposure in the workplace and a control program that includes provisions for engineering controls, work practices, hygiene

practices and facilities, air monitoring, record keeping and medical surveillance. The regulations also set limits for the exposure of workers.

A principal feature of the regulation is that the assessment and control programs, where necessary, are to be conducted by an employer in consultation with the joint health and safety committee.

What Will This Guide Tell You?

This guide describes general principles for meeting the requirements of the regulations covering the chemical agents that have been designated. It is not, however, intended to deal with the regulation for noise. The guide includes:

- an overview of the requirements of the regulations;
- a guide to conducting an assessment;
- basic principles for setting up a control program, including information on types of controls, personal protective equipment, air monitoring, record keeping and medical surveillance programs.

Guides For Each Substance

This general guide may be supplemented by separate guides for some of the designated substances. These provide more specific information on:

- application of the regulation;
- exposure limits;
- health effects;
- uses of the substance, and the forms in which it may be present in the workplace;
- the assessment and control program.

It is important that **both** this general guide to designated substance regulations and the guide to the appropriate substance be consulted. They alert employers, workers and others to factors that must be considered in assuring that the health of workers is protected. However, they provide only a synopsis of important principles that must be observed in order to comply with each requirement of the regulations; they are not intended to provide complete details on all aspects of health hazard control applicable to every situation. It will be necessary, in many cases, for the parties to refer to more detailed references, such as those listed in the back of this guide, or to consult specialists with training and experience in occupational health and hygiene. Sources of assistance include the Occupational Health and Safety Division, the Ontario safety associations, the Occupational Health and Safety Resource Centres and the Occupational Health and Safety Training Centre of the Ontario Federation of Labour, whose addresses are listed in the back of this guide. In addition, private consultants with industrial hygiene expertise may provide services for assessments and development of control programs.

1. An Overview of the Regulations

Are You Covered by the Regulation?

In most cases, designated substance regulations apply to employers and workers at workplaces where two conditions are met:

- the substance is present in the workplace, and
- a worker is likely to inhale, ingest or absorb some of the substance that is present.

Some of the regulations exempt certain employers and workers from all or part of the regulation. The regulations also differ in their treatment of construction projects. For details on the application of each individual regulation, consult the guide for the appropriate substance.

Who is Responsible for Implementing the Regulation?

The regulation must be implemented by the employer in consultation with the joint health and safety committee (the committee), which, in most cases, must be established under section 8 of the Act. Where committees are not required by law, such as in offices, the minister may order their establishment.

What is the Responsibility of the Joint Health and Safety Committee?

Except for workplaces specifically exempted by section 8(1) of the Act (such as offices), a committee is required where a designated substance regulation applies (see section 8 of the Act). For further

details on the general role of committees, consult the ministry's Guide for Joint Health and Safety Committees and Representatives in the Workplace. The committee is required as long as the regulation applies to the workplace, even if the assessment discloses that a control program is not necessary. This is so that a committee can continue to monitor the workplace for any changes that might make another assessment necessary.

The employer consults with the committee, which can make recommendations regarding the development of the assessment and the control program. The committee members must be given copies of both the assessment and the control program and must be provided with the results of air sampling tests.

The committee also receives, on a confidential basis, the examining physician's opinion of whether a worker is fit, fit with limitations or unfit for continued exposure to the substance. Under some regulations, the committees also receive the results and interpretations of clinical tests from the examining physician. The purpose behind this practice is to assist the committee in monitoring the effectiveness of the control program.

What Is the Exposure Limit for the Substance?

Workers must not be exposed to a greater airborne concentration level of a substance than is specified in the particular regulation. There are three types of control limits that may be specified:

1. The **time-weighted average** exposure refers to the average exposure of a worker over the course of a work-week. The time-weighted average exposure is calculated on the basis of 40 hours, in accordance with the Schedule in the regulation.

2. The **maximum concentration** is an exposure level that must not be exceeded at any time. Some of the Codes for

Measurement referenced by the regulations specify sampling times to determine the maximum concentration.

The lead and mercury regulations require that exposure to the maximum concentration shall not:

- exceed 15 minutes at any one time;
- occur more than four times in a workday;
- occur until at least 60 minutes after the last exposure to that concentration.

3. A number of designated substance regulations require employers to reduce exposure to the **lowest practical level.** In this case, the employer in consultation with the joint health and safety committee, must determine the lowest practical exposure level that can be achieved.

How Is the Lowest Practical Level Determined?

The lowest practical level will depend on the characteristics of the individual worksite. The employer is required to adopt those engineering controls, work practices and hygiene practices that a responsible and prudent employer would put into effect, taking into consideration the plant, equipment, engineering controls and work practices in the workplace, and what can realistically and reasonably be done by way of improvement, modification and replacement.

There are a number of factors that should be considered in determining whether the lowest practical level has been obtained. Some of these factors are:

1) The extent of the health benefits that will likely be obtained from improvements or modifications to existing engineering controls, etc. in the workplace.

2) The exposure levels that were achieved in the worksite in the past.

3) The exposure levels being met in similar worksites.

4) The cost of introducing new engineering controls or of modifying those already in place.

5) The technological feasibility of achieving lower exposure levels.

How Is Exposure Kept Below the Exposure Limits?

The employer must ensure that the exposure of a worker to the substance is within the levels specified by the regulation, by means of:

- engineering controls;
- work practices;
- hygiene practices and facilities.

These types of control measures are described in Chapter 4 of this guide. Specific details of how these controls will be applied must be included in the workplace control program.

Respiratory equipment must not be used to reduce worker exposure below the exposure limit except under the specific conditions outlined in the next section.

When Can Respiratory Equipment Be Used?

In most circumstances an employer must comply with the exposure limits without requiring workers to wear respirators. Before respiratory equipment can be used as a method of compliance, the employer must show that one of the following circumstances exists:

- an emergency: where workers are exposed to immediate danger, such as during a process upset, a spill or equipment breakdown;
- control measures do not exist or are unavailable;
- control measures are not reasonable or practical for the length of time or frequency of exposure or the nature of the process, operation or work;
- control measures are not effective because of a temporary breakdown.

What Is An Assessment and Why Is It Performed?

An assessment is essentially a detailed and methodical examination of the workplace where worker exposure to the designated substance may be occurring. It is performed to determine:

- whether workers are inhaling, ingesting or absorbing the substance at present or whether they are likely to do so in the future; and
- whether or not the health of a worker may be affected by exposure to the substance.

The conclusions of the assessment will assist the employer and the joint committee in deciding whether a control program is required. It is therefore important to remember that the assessment must evaluate not only the present state of worker exposure, but potential exposure as well.

The completed assessment must be in the form of a written report. The employer must give a copy of the assessment to each member of the committee.

When Is An Assessment Necessary?

An initial assessment is required for every workplace to which the regulation applies. Further assessments must be carried out

whenever there is a change in any process involving the use, handling or storage of the designated substance that may result in a significant difference in the exposure of a worker to the substance.

Who Conducts the Assessment?

The employer must ensure that the assessment is carried out and a report prepared. The employer must consult with the committee and receive its recommendations, if any, on the assessment. A team approach is desirable, involving the committee, plant personnel familiar with work processes, and, if necessary, specialists in occupational health and hygiene.

The employer may, if he chooses, contract a private consultant to perform the assessment. However, the employer remains responsible for ensuring that the assessment is properly conducted, that the committee is consulted and that the conclusions of the assessment are valid.

What Must Be Considered When Conducting An Assessment?

In performing the assessment, the employer must take into account:

- the methods and procedures used in the processing, use, handling or storage of the substance;
- the actual and the potential exposure of workers to the substance;
- the measures and procedures necessary to control such exposure by means of engineering controls, work practices, and hygiene practices and facilities.

Details on conducting an assessment are provided in Chapter 2 of this guide.

What Is the Control Program and Why Is It Necessary?

A control program consists of all measures that are taken to protect workers from exposure to the designated substance and of procedures to monitor exposure and worker health. Each program should be specially designed to suit the needs of the individual workplace. Hence, no two programs will be exactly alike, although they all must conform to several basic requirements.

When Is a Control Program Required?

A control program must be developed when the assessment has revealed that a worker is **likely** to inhale, ingest or absorb the substance **and** that his or her health may be affected by such exposure.

Who Is Responsible for the Control Program?

The employer is responsible for developing and implementing the control program and must do so in consultation with the committee. The committee may make recommendations to the employer regarding the measures and procedures to be incorporated into the control program and also regarding the way in which the program is carried out. Workers are required to comply with the provisions of the control program.

What Form Must a Control Program Take, and Who Receives a Copy?

The completed control program must be in the form of a written document. The employer must give a copy of the control program to each member of the committee, and must make it available at the workplace both in English and in the majority language of the workplace. The employer must also acquaint every worker affected by the program with its provisions.

What Must the Control Program Include?

The regulations require that every control program include provisions for:

1. Engineering controls, work practices, and hygiene practices and facilities to control worker exposure to the substance. For details on controls and work practices, see Chapter 4 of this guide and the guide for the appropriate substance.

2. Methods and procedures to monitor both the concentration of the substance in workplace air and the exposure of workers to the substance. The procedures for monitoring and sampling must meet the requirements of the Measurement Code referenced by the regulation, unless the employer in consultation with the committee chooses to use alternative procedures that are equal to or better than these methods in terms of accuracy and precision. The regulation requires that as soon as the results of monitoring are available, they be given to the committee, posted in a conspicuous location at the workplace for at least 14 days and kept by the employer for at least five years. For a further description of monitoring methods and procedures, see Chapter 6 of this guide.

3. Workers' records of exposure to the substance. These records must be maintained by the employer and must include the worker's name, date of birth and occupation as well as the respiratory equipment used and the monitoring results showing the worker's exposure to the substance. A copy of these records must be given by the employer to the physician who examines the worker.

4. Medical examinations and clinical tests of workers, the records of which are kept by the examining physician.

The medical examinations and clinical tests required by the control program are to be undertaken at the expense of the employer and must meet the requirements set out in the regulation and in the Code for Medical Surveillance referenced by the regulation. For further details, see Chapter 7 of this guide.

What Happens if There Is a Dispute Between the Joint Committee and the Employer Over the Assessment or Control Program?

The regulations provide a mechanism for resolving disputes between the employer and the committee over the need for an assessment or control program or over the adequacy of the assessment or control program that has been developed. The employer, the committee or a member of the committee may notify a Ministry of Labour inspector when a dispute arises. The inspector then investigates the problem and gives a decision in writing. This decision is subject to appeal to a director, as provided for in the Act.

2. The Assessment

The designated substance regulations require that an assessment be conducted to determine the extent to which workers are exposed to the substance. If such assessments are to be thorough and accurate, it is important that they be organized in a step-by-step manner, as outlined in this guide.

It may not be necessary to follow all of the steps suggested here -- common sense is required to develop an assessment tailored to the specific workplace. However, before beginning the assessment, you should become familiar with appropriate control methods and adverse health effects of the substance so that you will be alert to any indications that a problem may exist.

In conducting the assessment, you must take into account the procedures used in handling the substance, the actual and potential exposure of workers to the substance and the procedures necessary to control such exposure. Although you will want to make use of any data that have already been gathered on air quality, worker exposure and existing control measures, the core of the assessment should consist of information obtained from an inspection of the workplace to evaluate, at first-hand, the nature of worker exposure to the substance. This inspection may be supplemented by air sampling where necessary.

You may need to consult with occupational hygienists, engineers, designers, safety experts and occupational physicians or nurses when planning the assessment or evaluating the data. If required, expertise is available through the Occupational Health and Safety

Resource Centres, safety associations or the Ontario Federation of Labour (see addresses at the back of this guide).

The regulation requires that the employer consult with the joint health and safety committee when conducting the assessment. Clearly, it is advantageous for those responsible for the assessment to discuss procedures with the committee during the planning stage and to encourage committee participation at each step of the process.

Identify Materials

Step One. Identify the materials handled in the workplace that contain the designated substance. Familiarize yourself with the uses of the substance in your workplace. One way of finding out whether a designated substance may be in materials used in a workplace is to contact your suppliers and obtain from them material safety data sheets (MSDS) or other information on products that might contain the substance.

Record the quantities of the substance used, the manner in which it is handled and the physical form (e.g. solid, liquid, dust, fume, vapour, etc.) in which it is present.

Draw a Map

Step Two. Draw a sketch or a map of the plant lay-out that includes all areas where the designated substance may be present. Note the locations of sanitary, hygiene and eating facilities. An example of such a sketch is shown in Figure 1 on page 17.

The Process Flow

Step Three. Develop a process flow sheet for each process that involves the use of the designated substance. Essentially, this entails a step-by-step list or diagram that shows what happens to

materials containing the designated substance from the time they enter the plant to the time they leave. The flow sheet should indicate how the material is transformed at each step, the various pieces of equipment used, any by-products that may be produced and quantities of the material involved. Don't forget to include storage and transportation from one area to another. Number each step of the process and indicate with a corresponding number on your map of the plant lay-out the location of each step. An example of a process flow sheet is shown in Figure 2 on page 18.

Gather Information on Processes and Controls

Step Four. In preparation for your inspection of the workplace, **familiarize yourself with existing data on processes and control measures currently in use in the plant.** Record the following information, if available:

1. Engineering controls:

   - general flow of air through the plant;
   - types of ventilation systems used;
   - location of local exhaust ventilation hoods;
   - method of obtaining make-up air, and location of air inlets;
   - capacity and efficiency of ventilation systems;
   - measures taken to isolate or physically enclose the machine or process.

2. Work practices regarding handling, use and storage of materials.

3. Hygiene practices and facilities available for workers to wash and to change clothes.

4. Housekeeping procedures.

FIGURE 1

PLANT LAY-OUT

PAINT MANUFACTURE

LEAD

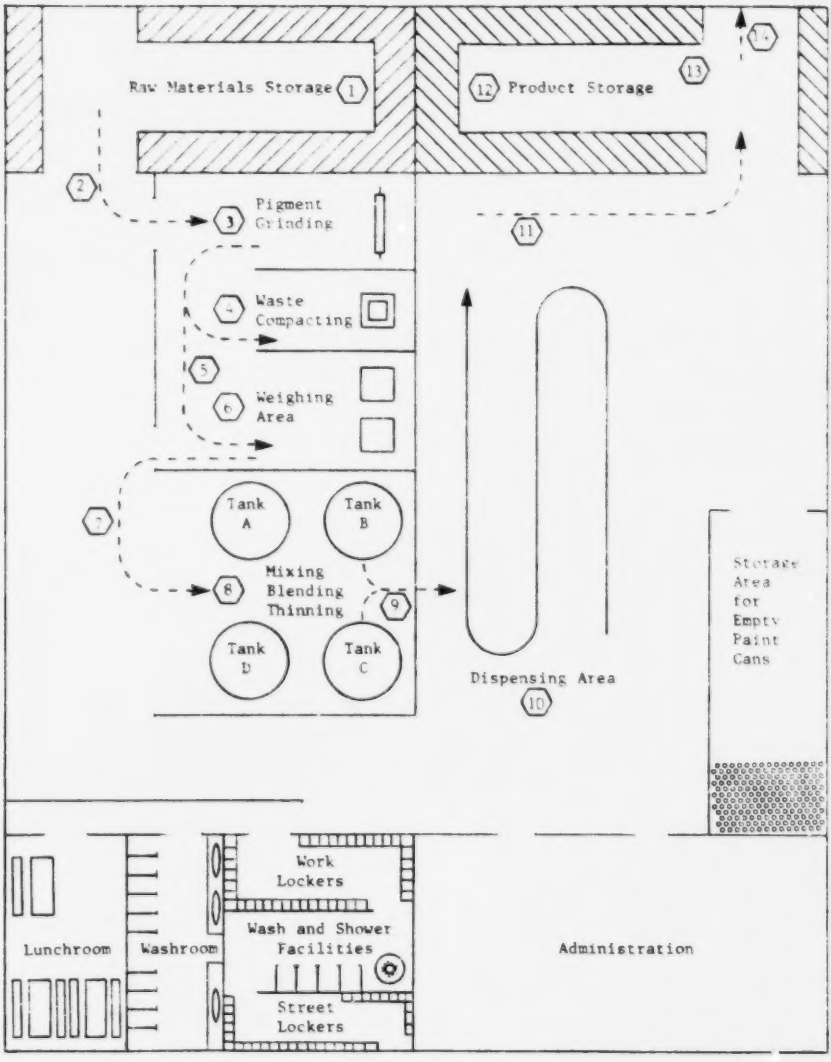
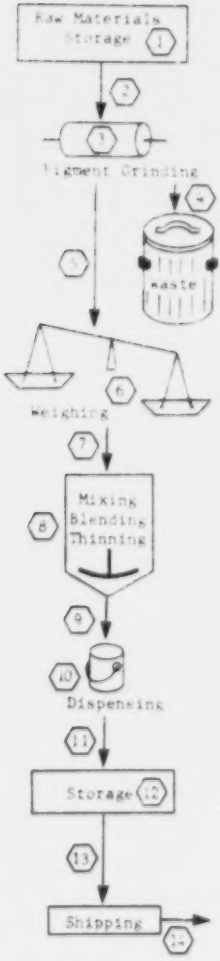


FIGURE 2

PROCESS FLOW SHEET

PAINT MANUFACTURE

LEAD



PROCESS DESCRIPTION

1. Raw materials on skids are moved by fork truck. 400 skids with six bags each are received per week. Each bag weighs 25 kilograms. Lead content of pigment varies from 0 to 95%. Open bags break during spillage.

2. Varieties of coarse raw materials to grinding area is carried out using a fork truck.

3. 10 bags of pigment are dumped by hand into the grinder. Dust generated is collected by an exhaust hood venting to atmosphere. Coarse pigment powder is ground into very fine powder during grinding (2 to 4 hours per batch).

4. Empty bags are carried by hand ten metres to the waste disposal where they are compacted under an exhaust hood, wrapped with plastic and disposed of at approved landfill by a certified waste hauler.

5. Pigment powder is dumped into small bins and transported by fork truck to weighing area. Bins do not have lids.

6. All materials are carefully weighed. Dust generated is exhausted.

7. Bins carrying approximately 500 kilograms of powdered materials are moved by fork truck to the mixing room. Bins do not have lids.

8. Air currents are dumped into large mixing tanks by opening a valve at the bottom of the cone shaped bin. Ten bins are needed for one batch. Dust generated by dumping is exhausted. Solvents are added to the mixing tank via a closed system from outdoor storage tanks. Mechanical agitation is used.

9. Paint is transferred via a closed system of pipes to the dispensing area.

10. Dispensing into 4.5 litre cans is done on an automated assembly line.

11. The sealed cans of paint are labelled and placed two in a carton on skids which are moved by fork truck to the storage area.

12. Skids are stored at floor level until shipped.

13. Trucks are loaded with skids of the product using the fork truck.

14. Shipping occurs by truck transport.

5. Use of personal protective equipment.

6. Contingency plans for spills or equipment breakdowns.

7. Medical surveillance programs.

8. Air monitoring programs; results of air quality tests.

9. Training programs to acquaint supervisors and workers with the hazards of the substance, precautions required for its handling, storage and disposal, personal hygiene practices and use of protective equipment.

10. Administrative controls to reduce the duration of worker exposure, such as work-rest schedules, job rotation or timing of hazardous procedures during periods when few workers are present.

Inspection of the Workplace

Step Five. Using the map as a guide, **conduct an inspection of the workplace, observing every step in each process to determine the potential for exposure of workers to the substance.** If the sequence of the tour follows the numbered steps on the map and flow sheet, it will help to ensure that you note all operations involving the substance. It will also help you to be more aware of potential hazards involved in the storage and transportation of the material.

The timing of the tour is important. To get an accurate picture of the extent of worker exposure, choose a time that is most representative of the work process. Be sure to note intermittent or infrequent operations, such as batch processing, receiving raw materials, clean-up techniques and maintenance. If procedures followed during the night shift are different from those followed during the day, make sure you take account of this in your assessment. Also, be sure that you consider seasonal differences in

exposure conditions. (For instance, there may be better general ventilation in the summer if windows and doors are kept open.)

Be sure to record the information collected during the tour.

Both worker and management members of the joint committee should participate in the inspection. As your inspection proceeds, these are the things you should note:

1. **Sources of Contamination**

   a) How is the substance stored?

      - Where are storage areas located in relation to the rest of the plant?
      - What kind of containers are used for storage?
      - What is the possibility of leakage or spills from these containers?

   b) What kind of equipment is used in processing or transporting the substance?

      - Is it open or enclosed?
      - How often is it used?

   c) What is the possibility of this equipment releasing the substance into the workplace air?

      - During normal use?
      - During an emergency or as the result of an accident?
      - During maintenance?

   d) What components of the equipment might leak some of the substance into the workplace (valves, pumps, tank vents or other sources of leaks or emissions)?

e) What maintenance precautions are taken to prevent this from occurring?

f) In what physical state is the substance used (liquid, gas or solid)?

g) In what form might the substance be released into the workplace (e.g. vapour, dust, fume, mist)?

h) What evidence of contamination can be seen (e.g. dust on floor or equipment) or smelled?

If there is reason to think that the process may cause emissions of the substance into the workplace, air sampling may be necessary. For details, see Chapter 6.

2. **Possibility of Worker Exposure**

a) How many workers are in each area/performing each job?

b) What are workers doing at each step of the process?

c) Where are they positioned in relation to sources of contamination and air inlets and outlets?

d) Do they come in direct physical contact with the substance? If yes, what is the risk of inhalation, ingestion or skin absorption?

e) Can dust or other evidence of contamination be seen on their work clothing, footwear, hair, face or hands?

f) Are they using appropriate protective equipment? Is suitable equipment available for use in an emergency? Is the equipment cleaned and maintained as necessary?

g) Is it possible that workers may be transporting the substance out of the work area on their hands, clothing, shoes or hair? If yes, are there hygiene facilities available so that they can wash themselves and change their clothes before leaving work?

h) What facilities are used to launder contaminated clothing?

i) Are signs posted warning that the substance is present? Are containers labelled with the name of the substance? Are material safety data sheets available?

j) Do any workers enter the area on an intermittent basis? If yes, are they adequately protected from exposure to the substance?

k) Are workers in an adjacent area likely to be exposed to the substance?

If worker exposure to the substance seems possible, medical tests may be advisable. For details, see Chapter 7.

3. **Experience of Workers**

a) Talk to workers in each area. Are they aware of any possible sources of contamination?

b) Are they experiencing any symptoms of ill health that may be related to exposure to the substance? It is advisable to speak to the plant physician or nurse to determine whether any patterns in health ailments have been noted.

c) Is there a written job procedure? Are workers familiar with it?

d) Do workers display thorough knowledge of safety procedures and precautions? Are they aware of the toxicity of the designated substance and the health effects it may cause?

4. **Engineering Controls**

(For details on appropriate control measures, see Chapter 4 and the guides for specific substances.)

a) Are there provisions to control exposure by isolating, enclosing or automating processes wherever reasonable?

b) Is there local exhaust and/or general ventilation?

c) What is the source of make-up air? Where are air inlets located?

d) Where are local exhaust hoods located? Are they being used properly?

e) What are the provisions for periodic maintenance and checking of control measures?

f) You may want to use smoke tubes to test the direction of air flow and the effectiveness of local exhaust hoods.

5. **Housekeeping Measures**

a) If the substance accumulates in the workplace in the form of a dust, is it cleaned up by means of wet mopping, vacuuming or other methods that avoid dispersing dust?

b) How is dust or contaminated refuse disposed of?

c) Are floors and walkways kept obstacle-free to reduce the possibility of spills and accidents?

d) How are spills cleaned up?

e) Are eating areas and sanitary facilities kept clean and free of contamination?

6. **Emergencies and Malfunctions**

a) What situations might lead to an accident, spill or leak? For example, could breakdown of equipment or operator error result in the release of hazardous concentrations of the substance?

b) What equipment and facilities are available to handle an emergency?

- Respiratory equipment?
- Protective clothing?
- Emergency clean-up equipment?
- Showers, eyewashes?
- First aid facilities?

c) Are workers and supervisors trained to deal with emergency situations?

- Is there a written emergency procedure?
- Are there emergency drills? How frequent are they?

d) Could unintended chemical reactions release hazardous concentrations of the substance?

Air Sampling and Medical Examinations

Step Six. After completing the inspection, **arrange to have air sampling and/or medical tests conducted** if there is reason to believe that the airborne concentration of the substance is substantial (i.e. near to or greater than the exposure value set out in the regulation) and/or that the health of workers may be affected by exposure to the substance. See Chapters 6 and 7 for details.

Organize Your Information

Step Seven. Compile and organize all the information that has been gathered through the review of existing data, tour of the workplace, sampling and testing. This information should be distributed to all members of the committee in preparation for analysis and evaluation, which is the next step in the assessment process.

Review and Analysis

Step Eight. Review and analyse the data to determine the actual and potential exposure of workers to the substance, the adequacy of existing control measures and any further measures necessary to control exposure. Your analysis should include an evaluation of:

1. potential sources of worker exposure to the substance;
2. present hygiene practices and facilities;
3. ventilation;
4. other engineering controls;
5. protective equipment procedures;
6. work practices, including provisions for emergencies;
7. training programs;
8. administrative controls;
9. medical surveillance programs;
10. air monitoring programs.

This evaluation should be done in co-operation with the joint committee. Consultation with occupational health experts may help you to evaluate the information you have obtained.

Writing the Assessment

Step Nine. Prepare a written assessment report that includes a summary of the information gathered and the analysis of these data. The report must state whether there is actual or potential exposure of workers to the substance and whether their health may be affected. The conclusion of the assessment must indicate whether or not a control program is necessary. One of four possible conclusions may be reached:

1. Although the substance is present in the workplace, there is no necessity for a control program since it is not possible that the health of workers could be affected by exposure to the substance.

2. Although workers are exposed to the substance and there are some engineering controls, e.g. exhaust ventilation, there is no need for a control program since the health of a worker is not likely to be affected because the risk to health would be minimal even if the engineering controls failed.

3. Existing control measures provide adequate worker protection; however, if these controls should fail or should not be maintained properly, the health of workers may be affected. If this conclusion is reached, then a control program must be developed that incorporates existing control measures and other mandatory provisions as required by the regulation.

4. Workers are exposed to the substance in a manner that can affect their health, and further control measures are needed to provide sufficient protection. If this conclusion is reached,

then a control program must be developed that establishes further control measures to protect the health of workers.

Conclusion of the Assessment

A draft of the assessment should be discussed by the joint health and safety committee. When agreement is reached on the assessment, a final report should be prepared. The assessment should be used to decide whether a worker's health may be affected by inhalation, ingestion or skin absorption and whether a control program will be needed. It may also help to design the control program, and should be kept at the workplace for review by inspectors of the Ministry of Labour.

3. Developing the Control Program

If the assessment reveals that the health of workers may be affected by exposure to the designated substance, the employer must put into effect and maintain measures and procedures to control the exposure of workers to the substance. These measures and procedures must be incorporated into a written control program that must include provisions for:

- engineering controls, work practices, and hygiene practices and facilities to control the exposure of workers to the substance;
- methods and procedures to monitor the concentration of the substance in workplace air;
- personal records showing the exposure of workers to the substance;
- a medical surveillance program;
- records of medical examinations and clinical tests of workers.

The employer is required to consult with the joint health and safety committee when developing the control program. Close co-operation with the committee can ensure that personnel at all levels will understand the program and share a commitment to carrying it out. Staff can also contribute their ideas on the sources of contamination and possible control measures. It is important that senior management become involved in the development of the control program and demonstrate a firm commitment to its implementation.

The control program should outline general practices as well as very specific measures to control exposure at each step in the production process. The assessment document will be of great value in developing these measures. A systematic review of each exposure problem noted in the assessment can be the basis for determining the most effective controls to apply in each situation.

The control program should identify the workers who are to be included in each of its provisions (e.g. the job categories that are to be included in air monitoring and medical surveillance programs; the workers who are required to comply with specified work practices or hygiene practices). While medical surveillance and air monitoring will be required for all workers who are subject to the control program, the frequency of monitoring and medical examinations or tests may vary depending upon the extent of worker exposure to the substance.

The control program should also include a timetable for implementation. Provisions for interim control measures may be necessary in some cases. For example, the program may specify personal protective equipment to be used pending installation of engineering controls.

The following chapters describe general principles of occupational hygiene that should be considered when establishing control measures. They also review requirements and recommended practices with respect to personal protective equipment, air monitoring, record keeping and medical surveillance.

4. Controlling Exposures

The designated substance regulations require that your control program include provisions for three general categories of controls: engineering controls, work practices, and hygiene practices and facilities. **Engineering controls** are methods of designing or modifying plants, equipment, ventilation systems, and processes to minimize the amount of substance in the workplace air. **Work practices and hygiene practices** are on-the-job activities that reduce the potential for exposure to a toxic substance. Some employers use **administrative controls** to limit the amount of time in which individual workers are exposed to the substance. These controls include job rotation schedules, work-rest cycles and timing of maintenance procedures. Another type of control is **personal protective equipment**, which is discussed in Chapter 5.

Engineering Controls Are the Best Defence

The best methods for controlling exposure to toxic substances are engineering controls incorporated into the design of the plant, equipment and processes. There are five basic types of engineering controls:

- substitution;
- process control;
- enclosure and/or isolation of emission source;
- local exhaust ventilation;
- general ventilation.

Substitution

Substituting less hazardous materials, equipment or processes can often be the least expensive and most effective control method. In some situations it may be possible to replace a designated substance with a less toxic material. For example, lead-containing paints may be replaced by paints containing other pigments; sandstone grinding wheels which generate silica dust may be replaced by aluminum oxide wheels. If the designated substance is completely removed from the workplace, the regulation would obviously no longer apply and the assessment and control program would not be required.

In other cases, a less hazardous form of the substance can be used. For example, using the material in the form of a paste rather than powder will prevent dust dispersal. It may be possible to change the process in a way that reduces emissions of the substance into the workplace. For example, dipping or painting with a brush instead of spray painting will considerably reduce the concentration of airborne paint.

Process Control

Improving instrumentation for mixing, metering and dispensing operations can be an effective way to prevent spills, reduce exposure to airborne contaminants and prevent direct skin contact with a substance. Suitable process controls can include:

- the use of wet methods in grinding or drilling operations to control dust levels;
- lowering process temperatures so that less vapour is given off;
- transportation of materials via mechanical rather than manual methods;
- the use of alarm signals that can warn of ventilation or equipment failure;
- over-pressure cut-off switches;
- automation.

Enclosure and Isolation

Enclosing a process or equipment can be very effective in reducing the amount of a substance released into the workplace. Keeping the enclosed process or equipment under negative pressure by means of exhaust ventilation and the use of double mechanical seals on pumps and valves affords still greater protection. When enclosed equipment is opened for cleaning or filling, special precautions should be taken to prevent release of the substance. Diligent maintenance of pumps, valves and gaskets is important in preventing the contaminant from escaping. Designated substances should be stored and transported in tightly sealed containers.

Isolation involves the separation of workers from processes involving the substance. Storage facilities or hazardous processes may be physically or geographically separated from areas of the plant where many workers are present. Where high risk manual operations are necessary, glove boxes, remote control devices or robots may be used to minimize exposure of workers. Alternatively, work stations can be situated in contaminant-free enclosures or booths especially where automated processes are used.

Local Exhaust Ventilation

Local exhaust ventilation is one of the most effective means of controlling workplace contamination by designated substances and should be used when other methods are not adequate to prevent exposure. A local exhaust ventilation system consists of four main parts:

- **the hood**, where contaminated air enters the ventilation system;
- **ducts**, which carry contaminated air away from its source;
- **the air-cleaning device**, which removes contaminants from air before it is discharged;

- **the fan and motor**, which draw air into the system and discharge it after cleaning.

The design of each of these parts must be suited to the particular process and contaminant in question. For this reason, the ventilation system should be designed by a specialist. When developing a control program, it is important to establish provisions for the design of an effective and appropriate local exhaust ventilation system and for proper maintenance of the system once it is installed. Even the best-designed system will fail to function well if it is not properly maintained. If fans, air cleaning devices and ducts are not cleaned regularly, they may become clogged with dust, which will prevent them from operating effectively. When changes in processes or additions to the original ventilation system are made, it is essential to evaluate the impact of these changes on the effectiveness of the ventilation system as a whole.

In developing the provisions in the control program that deal with local ventilation, the following principles should be borne in mind:

1. Hoods should be as close to the source of contamination as possible. The best type of hood completely surrounds the source of emissions so that there is no opportunity for the substance to enter workroom air. The shape of the hood should be designed to maximize exhaust of contaminated air.

2. The rate at which air is drawn into the hood must be sufficient to capture as much of the contaminant as possible. The ideal 'capture velocity' (the rate of air movement toward the hood at the source of contamination) will vary according to the type of process that generates the contaminating substance, the degree of air movement in the workplace and the distance from the hood. Cross-drafts in the workplace can significantly

affect the capacity of a local exhaust system to remove airborne contaminants.

3. Exhaust hoods should be located so that they do not interfere with the performance of work and so that contaminated air is not drawn into the breathing zone of the worker.

4. The velocity with which air is conveyed through the system should be high enough to prevent excessive settling of contaminants within the ductwork. Good duct design can also help prevent excessive settling of dust.

5. The fan should be located 'downstream' of the air cleaning device so that it is less likely to be damaged by contaminants in the exhausted air.

6. Air vented to the outside environment must be cleaned in accordance with the standards of the Ministry of the Environment.

7. An adequate and clean supply of make-up air is essential to the proper functioning of an exhaust system. Make-up air must be heated where required. The intake vent should be located so that contaminated exhaust air is not drawn into the workplace.

Detailed information on local exhaust ventilation is available in the references listed at the back of this guide.

General Ventilation

The principle of general, or dilution, ventilation is the use of large volumes of air to dilute the concentration of airborne contaminants. When the workplace contains hazardous contaminants such as a designated substance, this type of ventilation by itself does not

usually offer adequate control. It can, however, be used to prevent accumulation of contaminants that are not removed by other control methods. It is important that a general ventilation system include an adequate supply of make-up air to replace air removed by exhaust. If this is not provided, a negative pressure can be created within the workplace, which can adversely affect the operation of equipment and exhaust fans. The direction of air movement should be from clean, non-contaminating operations to dirty or contaminating operations.

Work Practices Can Ensure Safe Working Conditions

Well-designed and maintained engineering controls must be supplemented by diligent adherence to good work practices if workers are to be protected from exposure to a designated substance. These work practices should be spelled out in the control program and may include the following:

- standard work procedures;
- housekeeping;
- equipment maintenance;
- safety practices and emergency provisions.

A standard work procedure is important to ensure that each operation is performed in the safest possible manner. It is strongly recommended that this procedure be written down; this can help to simplify the training of new workers, promote understanding of safe practices among all parties in the workplace and prevent the omission of important health considerations.

Good housekeeping procedures are especially important when the designated substance is released in a particulate form. Proper design of the workplace can help to ensure that hygienic conditions are maintained. For example, the presence of ledges, beams and other surfaces on which dust can accumulate should be kept to a minimum. It is important that cleaning techniques do not contribute

to the dispersal of dust through the workroom atmosphere. To avoid such dispersal, cleaning should be performed using wet sweeping, sweeping compounds or vacuum cleaners equipped with special filters or other devices to prevent dust from being re-circulated into the air. Care must be taken to avoid occupational or environmental pollution when disposing of contaminated refuse.

Regular maintenance of equipment can help to prevent leaks or emission of a designated substance into the workplace. Equipment used for control practices, such as ventilation systems or vacuum cleaners, must also be well-maintained. Special precautions may be necessary when cleaning or maintaining equipment contaminated by a designated substance. For example, maintenance workers may require protective clothing and equipment, and other workers can be removed from the area during maintenance operations.

Safety practices and emergency provisions are required since exposure to a designated substance can occur through accidental spills and leaks. The control program should specify measures designed to prevent such accidents. These may include:

- storing materials in appropriate receptacles away from work areas, and proper ventilation of storage areas;
- posting warning signs and labelling hazardous materials;
- preventive maintenance and prompt repair of damaged equipment;
- keeping aisles, corridors or walk-ways well-lit and obstacle-free;
- minimizing the need to transport or transfer materials through the plant;
- using mechanical rather than manual means of moving materials wherever possible.

The control program should also provide for clean-up procedures to be used in the case of emergency. Spills and leaks should be cleaned up promptly to minimize the risk to workers. Where appropriate,

protective equipment, first-aid facilities, deluge showers and eye washes should be readily accessible for emergency use.

Hygiene Practices and Facilities

Personal hygiene practices can reduce the absorption of a designated substance by individual workers. These are especially important when the contaminant is released in a form that can accumulate on workers' hands, clothing and hair. If such contamination is not scrupulously cleaned off after a work shift, workers risk exposing both themselves and their families to the substance. In such circumstances, the control program should provide for **hygiene facilities** in which workers can shower and change into clean clothes.

Important principles to remember when planning for effective hygiene practices and facilities include the following:

1. Workers should wash hands before eating, drinking or smoking. They should be allowed enough time before meals and breaks for adequate personal hygiene.

2. Smoking, drinking, chewing and eating should be prohibited in work areas. Food and cigarettes should be stored in non-contaminated areas.

3. Hygiene facilities, where appropriate, should be designed to prevent contamination of clean clothes by dirty clothes. Well-designed hygiene facilities customarily feature showering and washing areas located between 'clean' and 'dirty' changing areas. Before beginning a shift, workers remove their street clothes in the 'clean' areas and store them in lockers or other receptacles. They then enter the 'dirty' areas, where they put on their work clothes. After the shift, work clothes are removed in the 'dirty' areas and either stored or decontaminated.

After removing work clothes, workers wash and shower before entering the 'clean' area, where they put on their street clothes. A sample floor plan for a double locker facility is illustrated in Figure 3 on page 40.

4. Fixtures and surfaces in hygiene facilities should be made of smooth, impervious materials that will not trap and accumulate a designated substance. Facilities should be regularly cleaned and maintained.

5. The facilities should be suitably heated and large enough to accommodate the number of workers using them. They should be supplied with sufficient hot and cold running water, soap, nail brushes and towels.

6. Lunch-rooms, rest areas, drinking fountains and vending machines should be located where there is no risk of contamination.

7. Workers should remove outer protective clothing and clean their hands, arms, face and nails before entering rest areas or lunch-rooms.

8. Worker education programs should stress the importance of good hygiene practices such as washing hands before eating and smoking, avoiding touching lips, nose and eyes with contaminated hands and thorough cleaning at the conclusion of a shift.

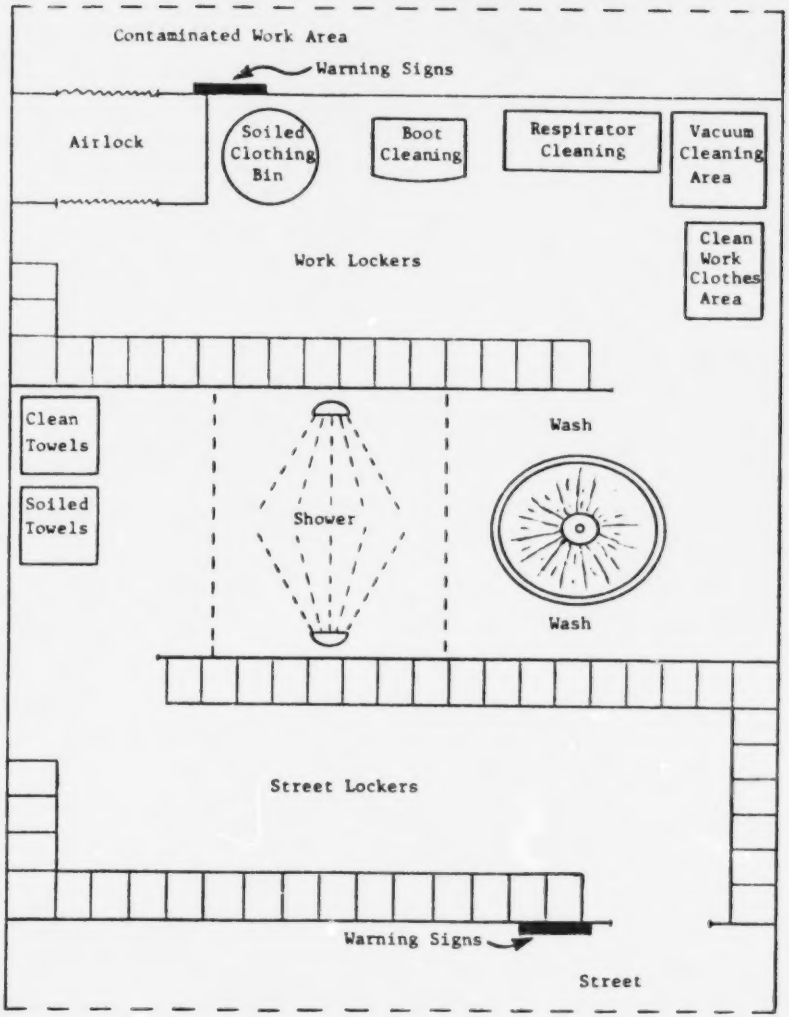
Administrative Controls Reduce Individual Exposures

Administrative controls comprise personnel practices that can reduce the exposure of individual workers to an environment contaminated by a designated substance. They may include:

- scheduling maintenance or other high exposure operations for times when few workers are present;
- job rotation schedules that limit the amount of time each individual worker is exposed to a designated substance;
- work-rest schedules that limit the duration of worker exposure to a designated substance.

FIGURE 3

DUAL LOCKER LAY-OUT



5. Personal Protective Equipment

Personal protective equipment includes respirators, protective clothing, footwear and face and eye shields that can reduce or prevent the absorption of a designated substance present in the environment. While it is important to include provisions for personal protective equipment in the control program, such equipment should never be used as a substitute for measures that control the emissions of the substance into the workplace.

Protective Clothing

The type of protective clothing selected must be appropriate to the substance and the process being used. It should be designed to provide the worker with maximum comfort and freedom of movement. Protective clothing may protect against the harmful effects of a designated substance in two ways:

1. It may act as a direct barrier between the substance and the skin. This is important when the substance can either damage the skin directly or be absorbed into the body via the skin. Where the prevention of direct skin contact is of concern, protective clothing should be made of impermeable material and should include gloves and footwear. Such clothing is often hot and uncomfortable to wear, and precautions should be taken to avoid heat stress.

2. It can prevent the contamination of the worker's street clothing, skin or hair by the substance. This can reduce absorption, inhalation or ingestion of the substance after

the worker has left the work environment. It also prevents the worker from transporting the substance to non-contaminated areas, where it may pose a risk to other workers or members of the community.

Such clothing should be made of fabrics designed to keep dust retention to a minimum, and should include head covering and footwear. It should feature close-fitting openings at the cuffs and neck, which can help to prevent penetration by the substance. This is especially important where street clothes are worn beneath protective clothing.

The control program should specify cleaning procedures to decontaminate used clothing. Workers handling contaminated clothing must be protected from exposure to the designated substance. The clothing should be cleaned by a laundry designed to handle the material; under no circumstances should it be taken home by the worker where it may expose family members to the substance. Protective clothing should be inspected regularly for damage.

Respiratory Protection

A respirator allows the user to breathe uncontaminated air by one of two methods:

- by acting as an air purifier and trapping contaminants on a filter or in a chemical cartridge as air is breathed in or
- by supplying clean air to the user from an external source.

The type of respirator required depends on the designated substance and the concentration in which it is present. Each designated substance regulation references a Code for Respiratory Equipment, which specifies the type of respirator required according to the concentration of the substance in workplace air. In selecting a

respirator, remember that the requirements of the Code are based on the assumption that the respirator is required to protect against one designated substance only. **If protection against more than one contaminant is necessary, the selection of respirators must take this into account.**

Air Purifying Respirators

Mechanical filter respirators protect against particulate matter such as dusts, mists, fume and smoke. **Chemical cartridge respirators** are used to trap vapours and gases. If both particulate and gaseous contaminants are present, a combination mechanical filter/chemical cartridge respirator should be used. Air purifying respirators are available in quarter mask, half mask and full facepiece styles. Full facepiece styles are generally required when there is a danger of eye irritation or direct skin contact.

Powered air purifying positive pressure respirators use a battery-powered or stationary pump to force air through the filter, creating a positive pressure within the facepiece so that any leakage is outward.

Atmosphere-Supplying Respirators

Supplied air respirators provide air to the breathing zone through an air line connected to a compressed air cylinder or to a compressor that picks up outside air. Air may be supplied in one of three ways:

- continuous flow, which maintains a positive pressure within the facepiece;
- demand, which supplies air only when the user inhales;
- pressure demand, which supplies air on inhalation, but also maintains a positive pressure within the facepiece.

A **self-contained breathing apparatus** (SCBA) is equipped with a source of clean air or oxygen and is carried by the user. It is used in emergency situations or when the use of supplied air respirators are not practical and where the concentration of contaminants is very high, and rapid escape may be necessary. SCBAs should be operated in the same way as a pressure demand respirator.

A Detailed Program for Respirator Use Is Essential

In most situations employers must comply with exposure limits by means of engineering controls, work practices, and hygiene practices and facilities without resorting to respirators. In the following exceptional circumstances, however, respirators may be used to reduce exposures below the exposure limit:

- an emergency: where workers are exposed to immediate danger such as during a process upset, a spill or equipment breakdown;
- where control measures do not exist or are unavailable;
- where control measures are not reasonable or practical for the length of time or frequency of exposures or the nature of the process, operation or work;
- where control measures are not effective because of a temporary breakdown.

If the exposure level exceeds the time-weighted average exposure limit or the maximum concentration limit in such circumstances, the employer must provide the worker with an appropriate respirator and the worker must wear it.

Some of the designated substance regulations (e.g., acrylonitrile, benzene and silica) require that wherever a worker is exposed to the designated substance, the employer must provide a respirator to the worker if one is requested.

The use of respirators must meet the requirements laid out in the Code for Respiratory Equipment referenced in each regulation.

A program of respiratory protection is effective only if scrupulous attention is given to all aspects of respirator selection, maintenance, testing and fitting. To help ensure this, one individual should be assigned responsibility for the respirator program. It is essential that written standard operating procedures be developed, as required by the Code. Guidance for developing these procedures can be found in the Canadian Standards Association (CSA) Standard Z94.4-M1982, 'Selection, Care and Use of Respirators'.

The written operating procedures should incorporate the following principles of good respirator use:

1. The type of respirator used must satisfy the requirements of the Code. Although it is not mandatory, it is recommended that the respirators be certified by the U.S. National Institute for Occupational Safety and Health (NIOSH) or The British Standards Institution (BSI).

2. Respirators (except continuous flow or pressure demand supplied air respirators) must be properly fitted so that there is a good seal between the facepiece and the skin. Because facial hair can interfere with a proper seal, users should be clean shaven. Respirators should be available in a variety of sizes and shapes to accommodate differences among workers.

3. There must be a regular program for the cleaning and maintenance of respirators by specially trained individuals. When one respirator is used by more than one worker, it must be disinfected after each use.

4. Where practical, respirators should be assigned to workers on a personal basis and marked with the user's name. This can help to assure proper fit and hygiene.

5. There must be a regular program for testing and inspecting respirators. Some fairly simple tests can be performed by workers themselves before each use, and instruction in testing techniques should be included in training programs. Details on test techniques are available from the manufacturer or can be found in the references cited at the back of this guide.

6. Respirators are often hot and uncomfortable to wear. They usually restrict verbal communication, and some users may experience breathing difficulty when wearing them. These are some of the reasons why the prolonged use of respirators should be avoided wherever possible. When this cannot be done, it is advisable to structure work-rest cycles or job rotation schedules in order to limit the problems associated with respirator use. It is also important that worker comfort be one of the major factors taken into account when selecting the type of respirator to be used.

7. The types of mechanical filters and chemical cartridges used must be appropriate to the form and concentration of the designated substance. Filters, cartridges and disposable respirators must be disposed of when they have reached their filtering capacity.

8. The quality of compressed breathing-air compressed oxygen, liquid air and liquid oxygen used with supplied air respirators must meet the requirements of CSA Standards.

9. Respirators must be carefully stored where they will not become contaminated by dust present in the workplace air. It is preferable to store them under negative pressure.

10. Workers must receive thorough training in the proper use of respirators. Those responsible for the maintenance, repair, testing and fitting of respirators should also receive comprehensive training.

11. Regular air monitoring should be conducted in areas where respirators are required to ensure that the type of respirator used is appropriate for the concentration of the substance.

6. Air Monitoring and Exposure Records

Air monitoring refers to a procedure for determining the concentration of a contaminant in workplace air. It usually involves collecting representative samples of the substance from the air and having them analysed to determine the quantity of the substance present.

There are a number of reasons why employers covered by the designated substance regulations may need to perform air monitoring:

- to determine the extent of exposure to the substance as part of the assessment;
- to demonstrate compliance with the exposure limits prescribed by the regulation;
- to obtain information that will aid in the choice of appropriate control measures and/or respirators;
- to aid in regular evaluation of the effectiveness and performance of existing controls;
- to obtain records of the personal exposure of workers to the substance.

Each regulation references a Measurement Code that specifies methods and procedures to be used for air sampling and analysis to demonstrate compliance with the exposure limits prescribed by the regulation and to meet the requirements of the control program if one is required. Unless an employer can demonstrate that he is using methods and procedures that are equal to or better than these, with respect to the factors of accuracy and precision, he must follow the standard practices laid out in the Measurement Code.

The air sampling train required by the Code consists of three components:

- a collection device, such as a filter holder, tube or impinger, which includes an appropriate medium that can remove the substance being measured from the air stream;
- a flow meter, which indicates the rate of air flow through the air sampling train; and
- a portable air sampling pump.

Air samples are obtained by drawing air through the collection device at a known rate for a known period of time. The quantity of the substance collected is then determined through laboratory analysis. From this information, plus the known volume of air that has been drawn through the collection device, it is possible to calculate the concentration of the substance in the sampled air.

The regulations require that the control program include provisions for air monitoring by the stipulated methods and procedures and for maintenance of records showing the personal exposure of workers to the substance. The program should outline a 'sampling strategy' that specifies where air sampling trains will be placed, the duration of sampling and the total number of samples to be taken in each survey. It should also indicate how frequently monitoring will be performed. Important factors to be considered when developing an air monitoring program are discussed below.

Personal or Area Sampling

Depending on the kind of information desired, monitoring may be performed by using either personal or area sampling.

Wherever possible **personal sampling** should be used for determining the exposure of a worker to the substance. Samples are obtained by sampling air as close as possible to the breathing zone of the worker.

Area sampling is performed by placing the sampling train at a strategically selected location in the workplace. It may be desirable for the following reasons:

- as a preliminary step to personal sampling to determine which workers may be at greatest risk;
- to investigate the effectiveness of control measures or to plan for needed controls;
- to determine the general concentration of a substance in a work area in order to assess what type of respirators or other protective mechanisms are required.

If the movement of workers in and out of sampled areas is carefully documented, it is possible to calculate personal exposure levels from the results of area sampling. This may be necessary when personal sampling methods are not available. This is not, however, a recommended method for determining personal exposure levels if suitable personal sampling methods are available.

Duration of Sampling

Duration of sampling (i.e. the length of time during which air is drawn through the sampling device) depends on the type of collection medium, exposure concentration being measured, (e.g. time-weighted average or maximum concentration), the anticipated airborne concentration and the sensitivity of the analytical method. The recommended minimum and maximum sampling durations for the various designated substances vary among the Codes referenced by the regulations. When determining the exposure concentration, sampling is usually conducted for six to eight hours, or for a full workshift, either as one sample or several shorter samples in sequence. Sampling for more than one workshift during a week may be necessary to determine interday variations in air concentrations and to determine the 40-hour time-weighted average. Conversely, a shorter sampling duration may be used if the results reflect representative exposure levels. For example, if

exposure conditions are uniform throughout the entire workshift, a two-hour sample might provide an accurate indication of exposure for that shift.

When determining compliance with the maximum concentration, if the regulation has specified a 15-minute short-term exposure (e.g. lead, mercury), a series of 15-minute samples should be taken during time periods when maximum emissions are expected. If the regulation has not specified the time period, then guidance is given on the sampling duration in the Measurement Code (e.g. vinyl chloride, asbestos and benzene).

When to Conduct Sampling

In most workplaces fluctuations occur in the concentration of contaminants in the air. Before establishing a sampling strategy to determine exposure levels, it is important to have thoroughly evaluated the nature of the operations in order to determine when and under what conditions the substance may be emitted. Representative sampling times should then be chosen so that it will be possible to calculate exposure over a full work-week. For example, if operations vary slightly from day to day, it may be sufficient to base your calculations of the 40 hour time-weighted average exposure on full-shift sampling conducted for one day. If there is considerable daily variation, then sampling should be conducted on different days representative of the different exposure conditions. If exposure conditions vary from week to week, sampling should be performed during a week when exposure levels are expected to be highest. It is recommended that an occupational health professional such as an occupational hygienist be consulted to determine an appropriate sampling program. The professional should consult with the joint health and safety committee and with workers and others with first hand knowledge of working conditions on the plant floor.

How to Calculate the Time-Weighted Average Exposure

The time-weighted average exposure of workers to the substance must be calculated according to the Schedule in the regulation. The results of these calculations may be certified by a Ministry of Labour inspector. This means that a ministry inspector may review the records to ensure that the appropriate data were used and that the results are representative of a worker's exposure.

In order to calculate the time-weighted average exposure accurately, it is essential that your sampling records indicate the nature of exposure conditions during the sampling period. These would include, for example, the operation or process being conducted during sampling, ventilation conditions and (for personal sampling) movement in and out of the work area during the sampling period.

To ensure that the sampling results used to calculate the time-weighted average exposure of a worker are truly representative, you should consider the following:

- What was the schedule and pace of the work?
- Was production rate similar for the entire 40-hour week?
- What was the natural ventilation condition during the entire week (e.g. opening or closing of doors and windows)?
- Was there mechanical ventilation? What type?
- Was the mechanical ventilation on, off or intermittent during the week?
- Was respiratory/protective equipment provided and used? What type? Was the same type of equipment used all week? Was the equipment properly fitted? Was it properly worn? Was it maintained and in good condition?
- Was the duration of the operation at the time(s) of sampling typical for the entire week?
- Is the same material/substance used each day, and is the percentage of mixture or quantity similar?

- Were the same workers present during the entire 40-hour time period?
- Were the samples taken under representative conditions for the workday and work-week?
- Was the worker exposure calculated as set out in the Schedule?
- Was the calculation made on the basis of area or personal samples or a combination of both?

If your samples are representative of exposure conditions over the course of the week, you will be able to determine from this information the 40-hour time-weighted average exposure concentration. To do this, you will need to estimate the number of hours per week that the worker was exposed to each concentration indicated by the samples. You then multiply the concentration C_1 by the time T_1 in hours during which the worker is taken to be exposed to such concentration. To determine the cumulative weekly exposure, it is necessary to repeat this calculation for each representative exposure period and to add these values together. This may be expressed as:

$$\text{Cumulative Weekly Exposure} = C_1T_1 + C_2T_2 + \ldots + C_nT_n$$

C_1 = Concentration No. 1

T_1 = Time Period No. 1 (in hours)

Finally, in order to determine the time-weighted average exposure, the cumulative weekly exposure must be divided by 40, regardless of the number of hours actually worked.

Example 1: Full Shift Sampling (five eight-hour days)

A worker is exposed to a solvent containing benzene. In order to determine the exposure to benzene, a series of five personal air samples were taken during the week. The results of the sampling and the number of hours the worker was estimated to be exposed can be listed as follows:

	Concentration	Total Time in Hours to Which the Worker is Taken to be Exposed to Concentration C_1 in a Week
Day 1	0.7 ppm (C_1)	8(T_1)
Day 2	0.5 ppm (C_2)	8(T_2)
Day 3	1.5 ppm (C_3)	8(T_3)
Day 4	1.0 ppm (C_4)	8(T_4)
Day 5	0.2 ppm (C_5)	8(T_5)

$$TWA = \frac{C_1 T_1 + C_2 T_2 + C_3 T_3 + C_4 T_4 + C_5 T_5}{40}$$

$$= \frac{5.6 + 4 + 12 + 8 + 1.6}{40}$$

$$= 0.78 \text{ ppm}$$

Thus, the worker's 40-hour time-weighted average exposure was 0.8 ppm.

Example 2: Full shift sampling using two consecutive six-hour samples each day.

In this case the work week consists of four 12-hour days rather than five eight-hour days.

	Concentration	Total Time in Hours to Which the Worker is Taken to be Exposed to Concentration C_1 in a Week
Day 1	0.6 ppm (C_1)	$6(T_1)$
	0.8 ppm (C_2)	$6(T_2)$
Day 2	0.4 ppm (C_3)	$6(T_3)$
	0.6 ppm (C_4)	$6(T_4)$
Day 3	1.4 ppm (C_5)	$6(T_5)$
	1.6 ppm (C_6)	$6(T_6)$
Day 4	0.1 ppm (C_7)	$6(T_7)$
	0.3 ppm (C_8)	$6(T_8)$

Note that even though the worker was exposed for 48 hours, the time-weighted average exposure is calculated for a 40-hour exposure.

$$TWA = \frac{C_1T_1 + C_2T_2 + C_3T_3 + C_4T_4 + C_5T_5 + C_6T_6 + C_7T_7 + C_8T_8}{40}$$

$$= \frac{3.6 + 4.8 + 2.4 + 3.6 + 8.4 + 9.6 + 0.6 + 1.8}{40}$$

$$= 0.87 \text{ ppm}$$

Thus, the worker's 40-hour time-weighted average exposure was 0.9 ppm.

Determining the Personal Exposure of Workers

The regulation requires the employer to maintain records of the personal exposure of workers to the substance. To do this, it is not always necessary to monitor each worker individually unless the number of workers in the workplace is very small. If every worker is not monitored, it is recommended that personal exposures be determined by assigning each worker to an appropriate **exposure category** within which similar conditions of exposure exist.

Choosing Exposure Categories

Exposure categories, in some cases, may be the same as job categories, but it is possible that workers who nominally perform the same job may be exposed to different levels of the substance. In determining how to group workers into exposure categories, you must consider all factors that can affect extent of exposure. Criteria used to assign workers to exposure categories include:

- nature of work performed;
- location of worker in relation to source of contamination;
- movement of worker in and out of contaminated areas.

To make record keeping easier, it is recommended that each exposure category be assigned a number.

How Many Workers to Monitor

If there are fewer than six workers in an exposure category, then all the workers in the category should be sampled. If the number of workers in the exposure category is six or greater, then monitoring should be performed on a sample of the workers.

The following chart developed by the U.S. National Institute for Occupational Safety and Health (NIOSH) shows the minimum number of workers that should be monitored according to the size of the

exposure category. Following this chart will give you 90 per cent confidence that at least one worker in the highest 20 per cent of exposure levels has been monitored.

Size of Group	*	6	7-9	10-14	15-26	27-50	51+
No. of workers to be sampled	*	5	6	7	8	9	11

* If the group is less than six workers, each worker is to be sampled.

(Adapted from **Occupational Exposure Sampling Strategy Manual,** U.S. Department of Health, Education and Welfare.)

In deciding which worker exposure categories to monitor, it is preferable to choose those workers who are estimated to be at greatest risk of exposure. These categories will usually be those in which the workers are closest to the source of emissions for the longest period of time.

Selection of workers from within an exposure category for monitoring should be done at random if it is not possible to determine which workers are at greatest risk. (A random sample can be selected by drawing names out of a hat or by assigning a number to each worker and using a random number table.)

Results May Vary Widely

It is not unusual for workers in the same exposure category to have a wide range of exposure levels due to personal work habits, differences in work operations or random variation in exposure and sampling conditions. For example, it may happen that five per cent of workers in one category have exposures two to three times higher than the average. For this reason, it would be erroneous to assign the average exposure level to all workers in the category. It is

therefore recommended that records show the average exposure and the range (highest and lowest) of exposure values obtained.

If any of the exposure values deviate excessively from the average (by a greater margin than can be explained by random variation), one of three problems may exist:

1. The deviant value may be due to a defect in equipment or an error in sampling. If this is the problem, the sampling equipment should be repaired if necessary and sampling should be re-done. This explanation is relatively rare.

2. The deviant value may be due to improper assignment of a worker to the exposure category. The criteria used should be reviewed.

3. The deviant value may be due to an unusual or extreme exposure condition. Investigation of work habits and operations should follow immediately. Further air sampling may be required.

From the air monitoring results, time-weighted average exposure levels should be calculated for all workers sampled. Air monitoring records should indicate the following:

- results of air monitoring for all workers sampled;
- calculated time-weighted average exposure levels for all workers sampled;
- range (lowest and highest) of time-weighted average exposure levels for each exposure category;
- average (mean) time-weighted average exposure level and standard deviation for each exposure category;
- some indication of past exposures to show trends in exposure levels in recent times.

In addition, the following information should be recorded each time air monitoring is performed:

- date of sampling;
- number of workers sampled in exposure category;
- average (mean) time-weighted average concentration and standard deviation for the exposure category;
- range (highest and lowest) of time-weighted average exposure values for the exposure category;
- results of personal sampling for the individual worker if it has been performed;
- use and type of respiratory protective equipment.

Posting and Record Keeping

The regulations require that the results of air monitoring be given to the joint committee and posted in the workplace by the employer as soon as they are available. They must be placed in a conspicuous location accessible to the workers for a period of at least 14 days. Employers are required to keep air monitoring records for a minimum of five years. Copies of these records must also be furnished to the examining physician. The examining physician must keep the records in a secure place for 40 years from the time such records were first made or for 20 years from the time the last of such records were made, whichever is the longer. Where the physician is no longer able or willing to keep the records, the records must be forwarded to the Chief Physician, Occupational Health Medical Service of the Ministry of Labour. Personal exposure records should include the following information:

- worker's name;
- social insurance number;
- date of birth;
- jobs or occupations performed at the workplace;
- date hired;
- date of termination;
- exposure category.

Frequency of Air Monitoring

The frequency with which air monitoring is performed should be discussed and then specified in the control program and be based on the exposure conditions in the individual workplace. Employers should seek the advice of an occupational health professional and consult with the joint health and safety committee and workers with first hand knowledge of working conditions on the plant floor.

If exposure levels regularly approach or even exceed the allowable limits, air monitoring should be performed at least on a monthly or quarterly basis. If there are any differences between summer and winter ventilation, air monitoring should be conducted during both seasons. Where exposure levels are usually much lower than prescribed limits, it may not be necessary to monitor so often.

Monitoring should always be performed when there are any changes in the process or conditions of exposure. In addition, monitoring should be conducted during and after emergencies, spills or other unusual operating conditions where a high exposure situation is likely or may persist.

Air Sampling Personnel

Sampling must be conducted by personnel who are competent to conduct air quality surveys, to calibrate, set up and operate air quality monitoring instruments and to accurately record essential information as required by the Code. The employer may want to either hire staff trained in sampling techniques or train employees who are already on staff to the degree required. Alternatively, the employer may contract with private consultants, including Occupational Health and Safety Resource Centres, to conduct air quality surveys, but the people hired must be competent to do the job.

Analysis of Air Samples

In most situations, air samples that have been collected will be sent to a private chemical laboratory for analysis. In choosing a laboratory, the employer must ascertain that it will analyse the samples according to the methods and procedures stipulated in the appropriate Code referenced by the regulation or by an alternative procedure that is equal to or better than, with respect to the factors of accuracy and precision, the measures and procedures in the Codes. It would be advisable for the employer to ensure that the laboratory chosen is competent to analyse what is required.

Information on laboratories that analyse air samples is available from the Occupational Health Branch of the Ontario Ministry of Labour, from the Ontario safety associations and from the Occupational Health and Safety Resource Centres.

7. The Medical Surveillance Program

The designated substance regulations for chemical agents require the control program to provide for medical surveillance that includes:

- pre-employment and pre-placement medical examinations;
- periodic medical examinations;
- clinical tests;
- health education;
- record keeping.

Medical surveillance serves as a backup to the major engineering and work practice control methods required by the regulation. The objectives of the medical surveillance program are both preventive and remedial. By providing a regular check on the health of workers exposed to the substance, the employer and the committee can be alerted to exposure problems that might otherwise go unrecognized. Health education to acquaint workers with the health effects of the substance and means of curtailing exposure is another preventive function of the program. Medical surveillance also ensures that remedial steps will be taken if a worker's health is affected by exposure to the substance or if clinical tests reveal excessive absorption of the substance.

This section of the guide is intended to acquaint the reader with the obligations of the various parties with respect to the medical surveillance program. While it briefly reviews the responsibilities of the physician, it is not meant to serve as a guide for conducting medical examinations or clinical tests. These are described in

greater detail in the Code for Medical Surveillance referenced by each regulation.

Who is Responsible for the Medical Surveillance Program?

The regulation and the Code for Medical Surveillance place a number of responsibilities on different participants in the workplace health and safety system. The employer is responsible for seeing that the medical surveillance program is established in accordance with the regulation and the Code. He must also ensure that the control program incorporates clinical tests as required by the Code and must bear the cost of required medical examinations and clinical tests. The joint committee receives advice and the results of clinical tests from the examining physician on a confidential basis and uses this information in evaluating and improving controls to reduce work exposures. Workers are required to undergo medical examinations and clinical tests as specified in the control program. The regulation and the Code also place specific obligations on the examining physician.

What Provisions Are Required for Medical Examinations?

The control program must incorporate provisions for medical examinations that include:

- a medical history;
- a physical examination;
- clinical tests as described in the regulation and the Code for Medical Surveillance.

Such examinations must be conducted before employment or placement of workers in jobs involving exposure to a designated substance, and at periodic intervals. The control program should identify the job classifications for which, due to the nature of exposure to a designated substance, medical surveillance is

required. The control program should include a provision for the selection of the examining physician(s).

Who Should the Examining Physician Be?

The examining physician should be selected in consultation with the joint health and safety committee. The examining physician may be the company doctor, a private consultant with whom the employer contracts services, a physician on the staff of a clinic whose services are used by the employer, or the worker's own physician.

If more than one physician is involved in the medical surveillance program, it is recommended that one serve as a co-ordinating physician. The role of this physician should be developed on a case-by-case basis. It is suggested that he or she could assist in identifying health trends, reviewing the interpretations of medical examinations and clinical tests, maintaining records and liaising with the joint health and safety committee.

If there is a dispute between the employer and the joint committee on the selection of the examining physician(s), an inspector may be called upon to make a decision.

What Is the Purpose of the Clinical Tests?

Clinical tests are intended to be an additional indicator of the extent of exposure of a worker to the substance. They are particularly useful in cases (e.g. lead) where knowledge of the levels of airborne concentrations of the substance is insufficient, in itself, to ensure that a worker is not overexposed. Some types of clinical tests measure the concentration of the substance in a worker's blood or urine, thus providing an indication of the amount that has been absorbed. Other types of tests are used to measure a specific function of the body that may be affected by exposure to the substance.

Some of the Codes for Medical Surveillance specify 'action levels' for the results of clinical tests. When the results of tests show that these levels have been reached, action is called for, as detailed in the Code. In some of the regulations, two grades of action levels are specified. When the lower grade is reached, the physician is required to review work practices, health status and personal hygiene. When the higher level is reached, and this result is confirmed by a second test, the worker must be removed from exposure.

The use of action levels does not mean that clinical tests are intended to be the only indicator used to protect the health of workers. The examining physician must use professional judgement in discerning other signs of possible overexposure to the substance. The tests, however, provide a safeguard mechanism in the event that other signs are not detected.

What Must the Physician Tell the Employer?

The regulations require the physician to advise the employer whether the worker is fit, fit with limitations or unfit for exposure to the substance. This determination is a professional judgement based on the results of medical examinations and clinical tests.

The examining physician must give this opinion without disclosing to the employer the results of examinations or tests.

It is recommended that each examining physician be provided with a copy of the assessment to help evaluate the worker's fitness for exposure.

What Else Must the Physician Report?

Some of the regulations require the physician to advise the committee, in writing, of the results of clinical tests, along with an opinion on how these tests should be interpreted. Other regulations

require only that the physician give the committee an opinion on the fitness of the worker for exposure. In all such cases, the committee receives this information on a confidential basis. If the physician has advised the employer that a worker is fit with limitations or unfit, he or she must also report this information to the Chief Physician of the Occupational Health Medical Service of the Ministry of Labour.

How Should the Employer and the Committee Act on Medical Information?

If the physician advises that a worker is 'fit with limitations or unfit', the employer is required to act on this information. The precise action taken will depend on the professional advice of the physician and on the requirements of the regulation and the Code. In many cases, there may be some choice concerning the course of action that can be worked out among the physician, the employer and the worker, with input by the committee.

If the results of clinical tests reach the action level for removal of the worker from exposure, then further exposure of the worker to the substance must be prevented until test results drop to the levels at which the Code permits return to the usual conditions of work. Where the results of clinical tests have not reached the action level or where there is no mandatory removal level, the physician may still advise that a worker is 'fit with limitations or unfit' on the basis of other signs of adverse health effects. In such a case, removal from exposure and return to the usual conditions of work are based on the judgement of the physician.

When a worker must be removed from exposure, this can be accomplished through isolation of the worker from the process or job re-assignment. Where these are not possible, temporary removal from the workplace may be necessary, and a compensation claim should be filed with the Workers' Compensation Board. Some Codes (e.g. silica, asbestos) require that the examining physician consult

with the Occupational Health Branch Medical Service of the Ministry of Labour and the Workers' Compensation Board before a worker is removed from exposure. Refer to the appropriate guide for further details.

The employer and the committee should use advice and information received from the physician to help evaluate and improve workplace controls. The information that the health of a worker has been affected by exposure to a substance or that a worker's absorption of the substance has reached an action level should always be taken as a signal that workplace controls are not operating optimally.

What Records Does the Physician Keep?

The examining physician must keep records of medical examinations and clinical tests of workers, along with the personal exposure records of the workers that have been provided by the employer. These are to be kept for 40 years from the earliest date of the records or for 20 years from the latest date, whichever is longer. If the physician ceases to be able or willing to keep these records, they must be forwarded to the Chief Physician of the Occupational Health Medical Service of the Ministry of Labour.

Who Can Get a Copy of the Records?

Copies of a worker's exposure records and the results of medical examinations and clinical tests may be given by the examining physician to the worker or the worker's personal physician on the written request of the worker. If the worker has died, the records may be released to the next of kin or the worker's personal representative, upon written request. Any other authorization by the worker for the release of the records is invalid.

Can the Records Be Computerized?

Some employers may wish to have medical records and exposure records stored in a computer system or on microfiche. Where a central data base is used, the physician must have access to both medical records and exposure records, and the employer or the hygienist must have access to the exposure records only. Such arrangements are acceptable provided that:

- confidentiality of medical records is maintained by using an appropriate security system;
- the physician has access to the exposure records; and
- the records are kept securely for the required period of time.

8. The Control Program— Putting It in Place

Once the control program has been developed, careful attention must be given to its implementation. Its success will hinge on the acceptance and participation of management, supervisors, workers and the joint health and safety committee.

The written control program must be given to each member of the committee and be made available in English and in the majority language of the workplace. The employer is required to acquaint every worker affected by the program with its provisions.

The following measures can help to ensure successful implementation of the control program:

1. Training programs to educate staff at all levels to the provisions of the control program. These programs should include:

   - an explanation of the health effects of the substance;
   - the rationale of the control program and the principles behind the measures chosen to control exposure;
   - specific work practices and hygiene practices that must be adhered to;
   - the duties and responsibilities of all the parties;
   - the proper use of personal protective equipment;
   - means of evaluating the effectiveness of the program;
   - channels of communication through which all workers and staff can have access to those responsible for the program.

2. A tight, but realistic, schedule for implementation of each control measure. In some cases, interim control measures, such as personal protective equipment, should be provided to control exposure while more comprehensive measures are being instituted.

3. Assigning responsibility for implementing the control program to one individual to ensure effective follow-through. Separate elements of the program can subsequently be delegated to other employees. The performance of those responsible for the program should be subject to periodic review. All staff should be made aware of the individuals who are responsible for each aspect of the program.

4. An evaluation system to monitor the progress of implementation during the set-up phase and to maintain a periodic review of the continued effectiveness of control measures once they are in place. Checklists designed to aid regular inspections of controls can be a useful tool for this evaluation process. A trouble-shooting system that involves the participation of all staff is another means to maintain the effectiveness of the program.

Employers and workers needing guidance on any aspect of the designated substance regulations should contact the nearest District Office of the Ministry of Labour for assistance. A list of District Offices can be found on pages 73, 74 and 75.

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Zenz, Carl. Occupational Medicine, Principles and Practical Applications. Chicago: Year Book Medical Publishers, Inc. 1975.

MINISTRY OF LABOUR DISTRICT OFFICES

Barrie
Industrial Health and Safety
114 Worsley Street
L4M 1M1
(705) 722-6642
1-800-461-4383*

Elliot Lake
Mining Health and Safety
Algo Centre
151 Ontario Ave.
P5A 2T2
(705) 848-2885

Hamilton
119 King Street West
L8N 3Z9
Construction Health and Safety
Industrial Health and Safety
(416) 521-7736
1-800-263-6906(3)*

Kingston
1055 Princess Street
K7L 1H3
Construction Health and Safety
Industrial Health and Safety
(613) 547-3414
1-800-267-0915*
Mining Health and Safety
(613) 547-3418
1-800-267-0915*

Kirkland Lake
Mining Health and Safety
4 Government Road East
P2N 1A2
(705) 567-5241

Kitchener
824 King Street West
N2G 1G1
Construction Health and Safety
Industrial Health and Safety
(519) 744-3101
1-800-265-8723*

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205 Oxford Street East
N6A 5G6
Construction Health and Safety
Industrial Health and Safety
Mining Health and Safety
(519) 439-3231
1-800-265-4707*

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Industrial Health and Safety
1500 Fisher Street
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P1B 2H3
(705) 476-2711
1-800-461-1654*

Ottawa
2197 Riverside Drive
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Construction Health and Safety
Industrial Health and Safety
(613) 523-7530
1-800-267-1916*

Peterborough
139 George Street North
K9J 3G6
Construction Health and Safety
(705) 742-3436
1-800-461-1425*
Industrial Health and Safety
(705) 876-1300
1-800-461-1425*

Richmond Hill
Mining Health and Safety
10720 Yonge Street
L4C 3C9
(416) 884-6551
1-800-268-3829*

St. Catharines
205 King Street
L2R 3J5
Construction Health and Safety
Industrial Health and Safety
(416) 682-7261
1-800-263-7260*

Sarnia
Industrial Health and Safety
700 Christina Street North
N7V 3C2
(519) 336-1200
1-800-265-1416*

Sault Ste. Marie
390 Bay Street
P6A 1X2
Construction Health and Safety
Industrial Health and Safety
(705) 949-3331

Sudbury
199 Larch Street
P3E 5P9
Construction Health and Safety
Industrial Health and Safety
(705) 675-4455
1-800-461-4000*
Mining Health and Safety
(705) 675-4464
1-800-461-4000*

Sudbury
260 Cedar Street
P3B 3X2
Mining Health and Safety
(Chief Engineers)
(705) 675-4468
1-800-461-4000*

Thunder Bay
435 James Street South
P7E 6E3
Construction Health and Safety
Industrial Health and Safety
(807) 475-1691
1-800-465-5016(7)*
Mining Health and Safety
(807) 475-1675
1-800-465-5016(7)*

Timmins
273 Third Avenue
P4N 1E2
Construction Health and Safety
Industrial Health and Safety
Mining Health and Safety
(705) 267-6231
Zenith 57740* (Mining)

Toronto East
2500 Lawrence Avenue East
Scarborough
M1P 2R7
Construction Health and Safety
Industrial Health and Safety
(416) 750-3537
1-800-268-6541*

Toronto West
2 Robert Speck Parkway
Mississauga
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Construction Health and Safety
Industrial Health and Safety
(416) 273-7800
1-800-268-2966(7)*

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500 Ouellette Avenue
N9A 1B3
Construction Health and Safety
Industrial Health and Safety
(519) 256-8278
1-800-265-5140(4)*

Head Office
400 University Avenue
Toronto, Ontario
M7A 1T7

Construction Health and Safety
(416) 965-7161
1-800-268-8013*
Industrial Health and Safety
(416) 965-4125
1-800-268-8013*

Mining Health and Safety
(416) 965-1329
1-800-268-8013*
Occupational Health
(416) 965-3211
1-800-268-8013*
Special Studies and Services
(416) 965-2493
1-800-268-8013*
Standards and Programs
(416) 965-8710
1-800-268-8013*

*Toll free line. For callers located within the area code but outside the local calling area of this city. Consult the blue pages in your local telephone directory for additional information. The Ministry may also be reached 24 hours a day through the emergency telephone number in Toronto (416) 965-1211.

SAFETY ASSOCIATIONS

Construction Safety Association of Ontario
74 Victoria Street
Toronto, Ontario
M5C 2A5
(416) 366-1501

Electrical Utilities Safety Association of Ontario
81 Kelfield Street, Unit 1
Rexdale, Ontario
M9W 5A3
(416) 249-7837

Farm Safety Association
Unit 22
340 Woodlawn Rd. W.
Guelph, Ontario
N1H 7K6
(519) 823-5600

Forest Products Accident Prevention Association
50 Exeter Street
Box 270
North Bay, Ontario
P1B 8H2
(705) 472-4121

Industrial Accident Prevention Association of Ontario
31st Floor
2 Bloor Street West
Toronto, Ontario
M4W 3N8
(416) 965-8888

Mines Accident Prevention Association of Ontario
147 McIntyre Street West
North Bay, Ontario
P1B 8K6
(705) 472-4140

Ontario Pulp and Paper Makers Safety Association
91 Kelfield Street, Unit 4
Rexdale, Ontario
M9W 5A4
(416) 249-8591

Transportation Safety Association of Ontario
2 Bloor Street East
Toronto, Ontario
M4W 3C2
(416) 965-8911

Ontario Hospital Association
Hospital Accident
Prevention Department
150 Ferrand Drive
Don Mills, Ontario
M3C 1H6
(416) 429-2661

College, University and School Safety Council of Ontario
c/o Safety Education Division
Workers' Compensation Board
80 Bloor Street West
Toronto, Ontario
M4W 3C3
(416) 927-4873

OCCUPATIONAL HEALTH AND SAFETY RESOURCE CENTRES

Northeastern Ontario Occupational Health and Safety Resource Centre, Cambrian College of Applied Arts and Technology
1400 Barrydowne
Sudbury, Ontario
P3A 3V8 (705) 566-8101 Ext.502

Resource Centre for Occupational Health and Safety
880 Oliver Road
Lakehead University
Thunder Bay, Ontario
P7B 5E1 (807) 345-4031

Occupational Health and Safety Resource Centre
Queen's University
25 Union Street
Kingston, Ontario
K7L 2N8 (613) 547-5749

Centre for Occupational Health and Safety
University of Waterloo
Waterloo, Ontario
N2L 3G1 (519) 884-8202

Occupational Health and Safety Resource Centre
University of Western Ontario
Room 2001, Engineering Science Building
London, Ontario
N6A 5B9 (519) 679-3305

OTHER SOURCES OF INFORMATION

Canadian Centre for Occupational Health and Safety
250 Main Street East
Hamilton, Ontario
L8N 1H6 (416) 523-2981

Ontario Federation of Labour
Health and Safety Training Centre
15 Gervais Drive
Don Mills, Ontario
M3C 1Y8 (416) 441-1939

Occupational and Environmental Health Unit
University of Toronto
Fitzgerald Building
150 College Street
Toronto, Ontario
M5S 1A1 (416) 978-4353

Occupational and Environmental Health Clinic
St. Michael's Hospital
30 Bond Street
Department of Occupational Health
3 D South
Toronto, Ontario
M5B 1W8 (416) 864-5138

Occupational Health Program
McMaster University
1200 Main Street West
Hamilton, Ontario
L8N 3Z5 (416) 525-9140, ext. 2333

Notes